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ABSTRACT

This paper explores the possible measurable effects of mentors (major professors) on the subsequent productivity of the mentor's students. Also asked is whether there are benefits to the productive scientist who acts as a mentor. Analysis is based on a population of male biochemists (N=66) who obtained their doctorates in 1957, 1958, 1962, and 1963. Various measures of departmental, mentor and/or student productivity and prestige were obtained. Sources included biographic information from American Men (and Women) of Science and productivity indications from the Science Citation Index and Chemical Abstracts. Results indicate no visible mentor effects, unless the postdoctoral context is one in which research productivity is encouraged. Other results indicate that the productivity of former students positively influences the research visibility of the mentor. (CS)

MENTORS HAVE CONSEQUENCES AND REAP RETURNS IN ACADEMIC BIOCHEMISTRY*

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MENTORS HAVE CONSEQUENCES AND REAP RETURNS IN ACADEMIC BIOCHEMISTRY

To explain the location and mobility of professionals within the stratification system of science represents a major, continuing research problem for sociologists of science. Two highly interrelated dimensions of the stratification system--the prestige of one's employment context and the volume and quality of one's produced research results--play a particularly large part in these sociological studies. B. Reskin (16) has summarized a number of factors that have been proposed as explanatory mechanisms. Among these she stresses the role of (adult) socialization into the norms of science, pointing particularly to the role played by the "quality" of the Ph.D. department and the scientific eminence of the candidate's "sponsor," whom we shall call hereafter the mentor.

In her excellent analysis of Nobel Laureates, Zuckerman (18) devotes a full chapter to what she terms "Masters and Apprentices in Science," a phrase that conveys well the theoretical basis for the importance that many sociologists attribute to the mentor's quality of performance both as a role-model and as a trainer of fledgling scientists. Despite this theoretical importance, systematic studies of the mentor's role in the location and mobility of former students within the stratification system are scarce. By all odds, the most thorough previous work on this topic is Reskin's analysis of productivity by and rewards to a set of doctoral chemists and the role played by their sponsors in these achievements. Zuckerman's thorough analysis is limited to the end of the curve, to the elite of U.S. scientists and most others have ignored the hypothetical relationship.

Even strong results would create a problem of interpretation. That is, clear evidence of a mentor effect on subsequent productivity of the mentor's students could reflect a) the mentor's successful role as "master" in the training process; b) the mentor's prestige as a sponsor into productive work contexts of otherwise possibly undeserving proteges; c) the mentor's membership

(together with the students') in a highly-rated academic department; d) a selective process whereby the better mentors (within the better departments) recruit the more talented students.

Even with all of this interpretive ambiguity, the results themselves are ambiguous. Thus Reskin concludes that, aside from the value of coming from a highly-rated Ph.D. department, the value of a highly-rated mentor is "slight" and does not increase productivity in the longer term (16, p. 502).

Our purpose in this paper is, first, to resurface the question of whether there are measurable mentor effects on their students' productivity after controlling for other possibly relevant variables. Second, we propose a new question: is there value to the mentor in being a mentor? To attack the first question is essentially to replow old ground, such as that dug up by Reskin. But we will go at it in a somewhat new way, using the idea of a "context threshold" of productivity. The second question, as we see it, has been altogether ignored. Why should a productive scientist spend his time with a predoctoral student acting as "master" or "mentor"? Might the act benefit his own career? If so, the entire process of location and mobility within the stratification system might better be reconsidered as a dynamic system with feedback effects, the mentor's status changing with that of the productivity of his or her students as they enter and move through the profession.

DATA AND MEASUREMENTS

Analysis is based on the population of male biochemists who obtained their doctorates in fiscal years 1957, 1958, 1962 and 1963.[1] Complete biographic information was obtained for 557 (83 percent) of the 668 males who obtained their degrees during this period. Biographic information was coded from the 10th through 13th editions of American Men (and Women) of Science.

Prestige of the doctoral department was measured with the complete 3-digit ratings of faculty quality of biochemistry departments, a partial listing of which appeared in Cartter (3). The prestige scores range from a low of 1.00 to a high of 5.00. The prestige of postdoctoral appointments in graduate departments was based on a weighted average of the Roose and Andersen (19) prestige scores for bioscience departments in the fellowship institution.[2] An average was used since the specific department of the postdoctoral appointment was not always available. These scores also ranged from 1.00 to 5.00. A second characteristic of graduate departments that has been coded was whether or not the department is located in a college of agriculture, a distinction that is in keeping with biochemistry's twin origins in medical and agricultural science.

The name of the dissertation supervisor was available for all but eight of the scientists. For each mentor the 1961 Science Citation Index was used to code the number of citations the mentor received to his or her first-authored papers published in the five year period ending in 1961. By restricting the count to citations in a five year period, the effect of different professional ages of the mentors was reduced. This measure is used as an indicator of the prestige or eminence of the student's mentor.

Productivity of the sample members was measured using counts of both publications and citations to them. Chemical Abstracts (4) was used to locate the articles published by the sample members, whether or not they were the senior author. Citations to these articles were coded from Science Citation Index (Vols. 1961, 1964, 1966, 1968, 1970 1972 and 1974). The name of the first author on multiple-authored papers where the cohort member was not the first author was used to locate citations to junior authored papers, thus downward bias in counts for scientists who were predominantly junior authors

was avoided. For a given year in the scientist's career, the publication measure reflects publication in a three-year period in that year. Since coverage of Science Citation Index and Chemical Abstracts increased during the period covered by our analyses, counts were standardized within years of the Ph.D. For further details, see Long (11).

HYPOTHESES

Our basic hypothesis is that the mentor acts, in Zuckerman's terms, as a master to the graduate student apprentice-in-research and that the more effective the mentor's own research productivity, the more successful will be the process of socializing the student both in the norm of high research productivity and in the means of achieving the norm. We recognize that, when the student's training is completed, the subsequent employment context can be expected to play an important mediating role in the hypothesized relation, as can the research eminence of the Ph.D. department. This translates into the hypothesis that the level of a mentor's citations is positively and significantly related to the level of publications and of citations received by a student throughout at least the early postdoctoral years. The hypothesized linkage is net of effects both of the rated quality of the doctorate-granting department and, for those who take a career in academia, of the employing department. Our own previous research (13) has suggested that a separate aspect of the predoctoral academic context must be taken into account. This is the college in which the doctoral department is located. We have found, for example, that Ph.D. recipients from departments in agricultural colleges are far less likely to enter postdoctoral training and, consequently, to pursue academic careers than are those from arts or medical colleges.

Our second hypothesis is that there is at least a potential return on the investment consisting of being a mentor, represented by a positive effect on the mentor's research eminence of highly productive former students. The hypothesized effect could take any of several forms such as coauthorship of papers resulting from the dissertation or by the student's acknowledgement of intellectual indebtedness through citations of the mentor's publications. Clearly, a proper test of this hypothesis would require regressing a mentor's publication or citation counts on earlier productivity counts of former students. However, we are not yet in a position to do this and must instead regress the mentors' citation counts in 1961 on productivity measures of former students in an early part of their career. We selected the fourth postdoctoral year for this purpose since by then most postdoctoral training had been completed and the former students were established in their careers.

RESULTS

To test the first hypothesis, we examined counts of both research papers published and citations received by the biochemists. Publications were counted for three three-year intervals, those ending in the first, fourth and seventh postdoctoral years, as indicated by Chemical Abstracts (4). We also counted citations received for postdoctoral years one, four and seven as reported in the appropriate editions of the Science Citation Index (9).

The initial results can be seen in Table 1, which displays both standardized regressions and zero-order correlation coefficients for each of the six dependent variables. These results can only be called a miserable failure to support the hypothesis of visible mentor effects. Although there is evidence of an effect at the zero-order level of analysis, it is pretty much wiped out when other aspects of the predoctoral career and of subsequent employment are

entered into the equations. There is a mentor effect on early postdoctoral citations, but this is rapidly extinguished as the career progresses, and as the employment context effect takes on a growing importance.

We reconsidered the hypothesis in light of these results and surmised that the great variety of postdoctoral employment contexts might be confounding the test, that there may be, in effect, an employment threshold below which the prospect of publication is so limited that the hypothesis may not even be testable. Accordingly, we retested it on the set of those who had secured academic jobs in highly-rated and presumably research-intensive universities. The results are displayed in Table 2. In this case the evidence supports the hypothesis reasonably well. The mentor's level of research visibility has a significant effect on the productivity of these former students, one that endures throughout at least their first seven postdoctoral years. In the case of citations, the effect appears to diminish through time, as could be expected, as the employment context takes on increasing importance, even for this highly placed subset of biochemists. Thus, it would appear that our hypothesis should have been phrased to state that, for those who make it into an environment that is conducive to research, a highly productive mentor has a positive effect on the subsequent research productivity of former students.

The initial results of testing our second hypothesis are displayed in the first block of Table 3. As we have already seen, the place of employment plays an important role in research productivity. Therefore we conducted stepwise regressions, controlling first for rated quality of the faculty in biochemistry at the mentor's institution and for the college setting, both of which are seen to be highly significant. Next, in recognition of the hypothesis that age negatively influences productivity, we entered the mentor's professional age. This is seen to have a statistically significant but extremely slight effect in

the hypothesized direction, increasing R^2 by only one percentage point. Finally, we got to the heart of the hypothesis by entering citations received in the fourth postdoctoral year to articles authored jointly by mentors and their former students. We simultaneously entered the average employment context variable for former students and the fraction who had taken postdoctoral training. These effects increased the R^2 by nearly seven percentage points, from .197 to .266. We take this as evidence of reasonably strong support of our second hypothesis: the productivity of former students positively influence the research visibility of mentors.

Finally, we return to the question of aging effects. While this is a controversial issue, the evidence, as ably summarized by Reskin (17), does not strongly support the hypothesis. We had earlier tested the hypothesis on the set of mentors with results similar to those summarized by Reskin: a quadratic fit was significant, but only barely so, and it promptly dissappeared when other factors were controlled. Nonetheless, we reasoned that there might be at least a grain of truth in the hypothesis, but that our quadratic test might be inappropriate. It occurred to us that two linear relations might be more nearly the case, positive for younger scientists and negative for older. We took this idea into account by partitioning the mentors into those no older than 23 career years and those no younger than 23 (this year forming a hypothetical watershed and therefore entered in both equations). The results are seen in the lower two blocks of Table 3. While there is no evidence of a positive age effect for younger mentors, there is rather strong evidence of a negative age effect for those who were older. The aggregate influences of former students on their mentor's research visibility was roughly equivalent, however, for both sets. That is, for both younger and older academic biochemists, the act of producing new doctorate scientists seems to have a payoff in the form of increased visibility of the mentor's research papers.

Table 1

STANDARDIZED REGRESSION COEFFICIENTS OF CITATIONS RECEIVED BY 549 DOCTORATE RECIPIENTS FROM U.S. UNIVERSITIES IN 1957-58 and 1962-63

Dependent Variables				Independent Variables: Mentor's Research Visibility[1]	College of Ph.D. Degree[2]	Rated Quality of: Ph.D. Department[3]	Rated Quality of: Employing Department[4]	Selectivity of Baccalaureate School[5]	R^2
Publications in Postdoctoral Years	Mean	S.D.							
-1 through 1	2.01	2.28	β	.089	.010	-.032	.113*	-.022	
			r	.104**	.045	.024	.122**	.012	.002
2 through 4	3.12	3.31	β	.001	.078	.038	.176**	-.042	
			r	.066	.091*	.068	.188***	.019	.042*
5 through 7	3.70	4.18	β	.034	.038	.058	.201***	.024	
			r	.112**	.069	.125**	.236***	.092*	.063**
Citations Received in Postdoctoral Year									
1	7.13	11.04	β	.164**	.066	-.028	.175**	.055	
			r	.217***	.136**	.080*	.228***	.123**	.089**
4	26.93	31.49	β	.110*	.131**	.079	.204***	.030	
			r	.217***	.177***	.163***	.277***	.130**	.121**
7	49.36	50.02	β	.064	.132**	.125*	.266***	.009	
			r	.198***	.168***	.205***	.336***	.126*	.151**
			Mean	16.92	0.65	3.12	2.40	4.96	
			S.D.	27.02	0.48	1.05	1.34	1.45	

[1]Number of citations received in 1961 to articles published in preceding five years (9).

[2]Coded 1 if arts college or medical school, 0 if college of agriculture.

[3]As rated by Cartter (3) for 1957-58 Ph.D. recipients, by Roose and Andersen (19) of 1962-63 recipients.

[4]Weighted average of bioscience departments' rated quality (19) in employing institutions.

[5]A composite measure for U.S. colleges and universities compiled by A. Astin (2).

Table 2

STANDARDIZED REGRESSION COEFFICIENTS OF SELECTED EDUCATIONAL CHARACTERSITICS ON PUBLICATIONS AND CITATIONS RECEIVED BY 189 BIOCHEMISTS WHOSE FIRST REGULAR EMPLOYMENT WAS IN A HIGHLY RATED UNIVERSITY

Dependent Variables			Independent Variables					
				Rated Quality of:				
Publications in Postdoctoral Years	Mean	S.D.		Mentor's Research Visibility	College of Ph.D. Degree	Ph.D. Department	Employing Department	Selectivity of Baccalaureate School	R^2
-1 through 1	2.24	1.95	β	.289***	.083	.025	.080	.035	
			r	.327***	.143*	.124*	.155*	.087	.125**
2 through 4	3.47	3.13	β	.133*	.068	.146*	.215**	-.160*	
			r	.221***	.071	.197**	.230**	-.072	.124**
5 through 7	4.55	4.45	β	.172*	-.054	.151*	.094	-.032	
			r	.230***	-.049	.237***	.129*	-.009	.090*
Citations Received in Postdoctoral Year									
1	10.03	13.74	β	.283***	.087	.066	.042	.077	
			r	.331***	.136*	.160*	.135*	.124*	.131**
4	35.80	35.41	β	.214**	.086	.107	.158*	-.027	
			r	.290***	.119*	.186**	.218***	.049	.125**
7	65.31	56.31	β	.150*	.058	.181*	.188**	-.035	
			r	.252***	.069	.248***	.243***	.049	.131**
			Mean	23.45	0.76	3.44	3.40	5.24	
			S.D.	29.40	0.43	0.89	0.57	1.52	

Table 3

STANDARDIZED REGRESSION COEFFICIENTS OF CHARACTERISTICS OF MENTORS AND OF THEIR FORMER STUDENTS ON MENTORS' CITATION LEVELS

Citations in 1961 to Mentors' Articles Published in 1956-1960		Mentors' Departments': Rated Quality	College	Age of Mentors	Mentors' Former Graduate Students': Total Collaborative Citations in Year 4	Average Quality of Employing Institution	Fraction With Post-doctorals	R^2 (All with P<.01)
All Mentors (n=337)								
Equation	1	.368***	.206***	--	--	--	--	.186
	2	.379***	.210***	-.103*	--	--	--	.197
	3	.266***	.171**	-.099*	.217***	.103*	.103*	.266
Zero-order	r	.379	.226	-.054	.320	.265	.233	--
Mentors of Professional Age ≤ 23 Years (n=248)								
Equation	1	.413***	.188**	--	--	--	--	.210
	2	.412***	.185**	.017	--	--	--	.211
	3	.296***	.154*	.018	.224***	.077	.120*	.289
Zero-order	r	.419	.200	.083	.327	.264	.253	--
Mentors of Professional Age ≥ 23 Years (n=105)								
Equation	1	.326**	.239*	--	--	--	--	.183
	2	.315**	.229*	-.243*	--	--	--	.241
	3	.192*	.151	-.246**	.199*	.190*	.098	.336
Zero-order	r	.356	.279	-.269	.347	.206	.368	--

FOOTNOTES

1. Female doctorates were excluded from consideration due to their small number and the difficulty encountered in obtaining complete information on their careers from biographic sources.

2. The complete Roose and Andersen prestige scores were kindly provided by Charles J. Andersen.

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